

10/573545
MRO Rec'd PCT/PTO 27 MAR 2006

1 Description

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3 Device for monitoring the leakage current of a surge
4 arrester

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6 The invention relates to a device for monitoring the leakage
7 current of a surge arrester in accordance with the
8 precharacterizing clause of the main claim.

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10 Surge arresters for electrical power transmission systems
11 are extremely reliable devices. However, it is often
12 nevertheless desirable to monitor the operating state of the
13 arrester. This is particularly the case when the devices are
14 subject to unusually stringent requirements, for example
15 owing to the design or environmental conditions, or are
16 installed at particularly significant points in the system,
17 such as at machine transformers or strategically important
18 substations. In this case, the user would wish to be able to
19 use monitoring devices to identify in good time whether the
20 arrester is capable of reliably arresting surges having the
21 specified power content at any time or whether the arrester
22 has been damaged or is at risk of failure. In addition to
23 the established method of introducing a monitoring spark gap
24 in series with the arrester, in the case of which witness
25 marks on the polished electrodes of the spark gap are
26 evaluated, and in addition to the method of using surge
27 counters which register the occurrence of an arresting
28 process above a specific amplitude, methods involving the
29 measurement of leakage currents are known in particular in
30 the case of modern metal-oxide arresters. In the case of
31 metal-oxide arresters, the active part is not DC-isolated
32 from the power supply system but is connected permanently to
33 the voltage. The electrical properties of the active part
34 are thus reflected at any point in time in the leakage
35 current through the arrester. So-called total leakage
36 current measurement is known, in the case of which the peak
37 value for the total leakage current is usually evaluated,
38 use being made of the fact that an increasing resistive

1 component is superimposed on the normally predominantly
2 capacitive leakage current as the temperature of the active
3 part increases or as the voltage applied to said active part
4 increases, and this increasing resistive component increases
5 the total leakage current. Various influencing variables
6 which are included in the total leakage current may,
7 however, result in erroneous interpretations, and only a low
8 degree of information quality can be achieved with this
9 method.

10
11 The Patent Abstract of Japan JP 11307226 A has disclosed a
12 monitoring device for a surge arrester. The monitoring
13 device is supplied from an external power supply device. The
14 voltage produced by this external power supply device is
15 synchronized with the system voltage of the surge arrester
16 in order to ensure monitoring of the surge arrester.

17
18 Furthermore, the Patent Abstract of Japan JP 2003037932 A
19 has disclosed a surge arrester which has a device which
20 monitors the ageing of the arrester. Leakage-current
21 monitoring detects the leakage current of the surge
22 arrester. In addition, the number of arresting processes of
23 the surge arrester is monitored. When a predetermined number
24 of arresting processes has been reached, correspondingly
25 differently colored light signals are output.

26
27 Patent Abstracts of Japan JP 09145759 A and JP 2000321318 A
28 have each disclosed apparatuses for monitoring a surge
29 arrester. For monitoring purposes, the leakage current of an
30 arrester is monitored and evaluated in a computer unit. For
31 this purpose, a Fourier transformation is carried out, for
32 example. The result of the analysis is represented in each
33 case on a display device.

34
35 The Patent Abstract of Japan JP 03001476 A has disclosed a
36 monitoring device for inspecting a surge arrester. An
37 instrument transformer is inserted into the ground current
38 path of a surge arrester. In this case, the ground

1 connection forms the primary winding. The instrument
2 transformer is fed an inspection current from an external AC
3 voltage source.

4

5 The Patent Abstract of Japan JP 08017552 A has disclosed a
6 device for monitoring a leakage current of a surge arrester.
7 The leakage current of the surge arrester is monitored by
8 means of a detection device. A resistive component is
9 calculated from the measured leakage current by means of a
10 computation unit. This resistive component of the leakage
11 current is used to diagnose the state of the surge arrester.

12

13 The zinc oxide material used, for example, for metal-oxide
14 arresters has a conductance which is nonlinear as a function
15 of the voltage and leads to the formation of a third
16 harmonic component in the resistive leakage current of the
17 arrester when a sinusoidal voltage is applied. If the
18 resistive component of the leakage current is increased, for
19 example by means of degradation, this results in a shift to
20 the range of altered nonlinearity of the characteristic and
21 thus in a further rise in the third harmonic component
22 content. Methods are therefore known in which analysis of
23 the third harmonic of the leakage current is carried out.

24 For this purpose, the leakage current is generally output
25 via a measuring element and passed via a filter arrangement,
26 by means of which the third harmonic component is filtered
27 out and is evaluated in terms of its amplitude. However, at
28 present this method has the disadvantage that the available
29 devices are costly and require a high degree of experience
30 for correctly measuring and interpreting the measured
31 values. In addition, these devices require auxiliary power
32 for their voltage supply and are therefore generally not
33 used for continuous long-term monitoring on arresters.

34

35 The invention is therefore based on the object of providing
36 a device for monitoring the leakage current of a surge
37 arrester using the third harmonic of the leakage current, in
38 the case of which no auxiliary power is required for the

1 supply of the components and the measurement results can be
2 evaluated in a simple manner, and which can be produced in a
3 cost-effective manner, with the result that continuous long-
4 term monitoring of the surge arrester is possible.

5

6 This object is achieved according to the invention by the
7 characterizing features of the main claim in conjunction
8 with the features of the precharacterizing clause.

9

10 As a result of the fact that the filter arrangement is
11 connected to an evaluation circuit for the third harmonic,
12 which, if appropriate, outputs at least one warning signal
13 to a display apparatus which is connected to the evaluation
14 circuit, and the fact that a transformer is connected in the
15 arrester circuit, via which transformer the power for a
16 voltage supply to the filter arrangement and the evaluation
17 circuit can be output, no auxiliary power is required for
18 the electronic components, i.e. the latter are fed the
19 leakage current, and no user-dependent erroneous
20 interpretation is possible and only low demands are placed
21 on the qualifications of the user since the result of the
22 monitoring is displayed. Furthermore, the device can be
23 produced from standard electronic components, as a result of
24 which it is cost-effective. The device can therefore be
25 installed permanently at the arrester for continuous
26 monitoring purposes.

27

28 The measures specified in the dependent claims make
29 advantageous developments and improvements possible. A
30 measuring resistor can advantageously be used as the
31 measuring element, but the use of a current-compensated coil
32 arrangement comprising a current compensator is also
33 possible.

34

35 An active bandpass filter having a frequency of 150 Hz can
36 be used as the filter arrangement, and a microprocessor can
37 be used as the evaluation circuit. In one simplified

1 embodiment, the microprocessor can be replaced by a single
2 discrete or integrated threshold value switch.

3

4 In one advantageous embodiment, the display apparatus has
5 one or more light-emitting diodes, in which case only one
6 light-emitting diode can be provided for the simplified
7 version with the threshold value switch, which light-
8 emitting diode displays the instance of a predetermined
9 threshold value being exceeded. However, three light-
10 emitting diodes with the colors of a traffic light are
11 particularly advantageously connected to the microprocessor
12 and display the fault-free, the critical and the faulty
13 operating modes. It is particularly advantageous to connect
14 a coil arrangement having a toroidal core and two windings,
15 which are wound around the toroidal core and whose
16 connections are passed to the outside, into the arrester
17 circuit, since, in the critical case, i.e. when the
18 evaluation circuit outputs a warning signal, an external
19 measuring device can be connected which can carry out a more
20 accurate measurement and evaluation of the operating state.

21

22 Exemplary embodiments of the invention are illustrated in
23 the drawing and will be explained in more detail in the
24 description below. In the drawing:

25

26 figure 1 shows one circuitry refinement of the monitoring
27 device according to the invention,

28

29 figure 2 shows a further embodiment of the checking circuit
30 used in figure 1 for the third harmonic, and

31

32 figure 3 shows a further embodiment of the evaluation
33 circuit used in figure 1 with a display.

34

35 The device for monitoring the leakage current illustrated in
36 figure 1 has a metal-oxide arrester 1 having a protection
37 spark gap 2 for arrester currents and the actual leakage
38 current path 3. In addition to the arrester 1, the device

1 comprises three switching units, a voltage supply unit 4, a
2 checking circuit 5 for the third harmonic and an evaluation
3 unit 6. The checking circuit 5 has a measuring resistor 7,
4 which is connected into the leakage current path 3, and an
5 active bandpass filter 8 having a mid-frequency of 150 Hz.
6 In addition, a coil arrangement 9 is arranged in the leakage
7 circuit 3, said coil arrangement 9 having a toroidal core 10
8 and two coils 11 wound around the toroidal core, the
9 connections of the coils being passed to the outside for
10 connection to an external measuring device.

11

12 The evaluation unit 6 essentially comprises a microprocessor
13 circuit 12 and three light-emitting diodes 13, 14, 15,
14 which, in the exemplary embodiment, are selected to be the
15 colors of a traffic light, namely green, amber and red. Of
16 course other light sources can in principle also be used, in
17 which case, if appropriate, one or more audible display
18 elements are also conceivable in place of the visual display
19 elements.

20

21 The voltage supply unit 4 comprises a transformer 16, whose
22 primary winding 17 is connected into the leakage current
23 path 3, and whose secondary winding 18 is connected to a
24 switched mode power supply 19 having a rectification circuit
25 and a filter circuit. The bandpass filter 8 and the
26 microprocessor circuit 12 are connected to the outputs of
27 the switched mode power supply 19 for their voltage supply.
28 The auxiliary power is output, floating, from the leakage
29 current flowing in the leakage current path 3 via the
30 transformer 16, the secondary coil 18 providing the switched
31 mode power supply 19 with an alternating current. The
32 switched mode power supply carries out rectification and
33 filtering and makes a positive and a negative DC voltage
34 having a corresponding zero potential available at its
35 output.

36

37 During operation of the arrester 1, the leakage current is
38 checked by the measuring resistor 7 and passed on to the

1 active bandpass filter 8, which filters out the third
2 harmonic from the checked leakage current. The
3 microprocessor circuit 12 evaluates the third harmonic on
4 the basis of the magnitude of its peak value and drives the
5 LEDs 13 to 15. For this purpose, the microprocessor circuit
6 12 contains three threshold values, in which case, in the
7 event of a peak value below a first threshold value, normal
8 operation is indicated by a green LED 13, in the event of a
9 peak value above the first threshold value but below the
10 second threshold value, the critical range is indicated by
11 an amber LED 14, and, in the event of a peak value above the
12 second threshold value, faulty operation is indicated by a
13 red LED.

14

15 As has already been explained above, the coil arrangement 9,
16 which can be connected as a current-compensated coil, is
17 used merely as an additional sensor for an external
18 measuring device for precise, compensated measurement of the
19 third harmonic, if, for example, the amber LED 14 blinks.

20

21 Figure 2 illustrates a further embodiment of a checking
22 circuit 5, which can be used in place of the checking
23 circuit shown in figure 1, i.e. the measuring resistor 7
24 shown in figure 1 is replaced by a current-compensated coil
25 arrangement, which has a toroidal core 20 having two coils
26 21, 22 and a current compensator 23 connected to the
27 connections of the coils 21, 22. In this case, the total
28 magnetic field of the coil arrangement is brought to zero by
29 means of a reverse current, with the result that the
30 measured voltage is available at the output of the current
31 compensator 23. The active bandpass filter 8 in turn filters
32 out the third harmonic.

33

34 Figure 3 illustrates one variant of the evaluation unit 6,
35 in the case of which the microprocessor circuit 12 is
36 replaced by a single threshold value switch 24, which has
37 only one threshold value for the display of the critical
38 operating range. In this exemplary embodiment, there is only

1 one LED 25, which can illuminate or blink amber, for
2 example.

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4 The coil arrangement 9 can also be provided in all of the
5 exemplary embodiments.

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